

What is claimed is:

1. An encoder for a wide-band low transmission rate speech signal, the encode comprising:

5 a pre-processing and down-sampling unit, which down-samples a speech signal frame sampled at a high frequency, at a low frequency, and outputs a speech signal frame without DC components;

10 a LPC analysis and ISP quantization unit, which receives the down-sampled speech signal, determines a linear prediction coefficient of the received speech signal frame, converts the linear prediction coefficient into an ISP coefficient, quantizes the converted result, and outputs an index of the ISP coefficient;

a residual signal calculation unit, which calculates a residual signal that models an excitation signal of a synthesis filter for the down-sampled speech signal;

15 a random vector generation block which generates a random vector for modeling the excitation signal;

a gain calculation block, which calculates a gain for scaling the random vector; and

20 a gain quantization block, which quantizes the gain and creates an index of the gain.

2. The encoder of claim 1, wherein modeling is performed for each of two sub-frames of the speech signal frame and is performed by generating a random sequence using the random vector and multiplying the random sequence by the gain.

25 3. The encoder of claim 2, wherein the random vector is generated by storing a seed generated by a predetermined method for each of the sub-frames.

4. The encoder of claim 3, wherein the seed is obtained, by generating a value obtained by shifting a first index among the two indexes transmitted by the 30 LPC analysis and ISP quantization block to the left by 8 bits, performing an exclusive OR operation on the shifted value and the second index among the indexes, setting the result as a first seed value (seed 0), shifting the second index to the left by 8 bits, performing an exclusive OR operation of the second shifted value and the first index,

setting the result as a second seed value (seed 1), and determining the maximum value of the seed 0 and the seed 1 as a final seed value.

5. The encoder of claim 1, wherein the gain is calculated based on the residual signal and the random vector.

6. The encoder of claim 1, wherein the ISP index and the gain index are quantized to 14 bits and 6 bits, respectively.

10 7. The encoder of claim 1, wherein the gain is quantized by quantizing a present prediction error vector obtained by subtracting a predicted value of a pre-quantized prediction error vector value for a preceding frame from the gain.